

# EMISSIONS MONITORING SYSTEMS

## User manual

### OPACITY MONITOR MRU OPTRANS 1600



<b>1</b>	<b>Introduction.....</b>	<b>4</b>
1.1	General.....	4
1.2	Safety Instructions.....	4
1.3	General.....	4
1.4	Unpacking and Inspection.....	5
1.5	Installation.....	5
1.6	Storage.....	5
1.7	Repackaging for Shipment.....	5
1.7.1	Interface.....	5
1.8	Operation and Probe Instruction.....	6
<b>2</b>	<b>System Requirements.....</b>	<b>7</b>
2.1	General Requirements.....	7
2.2	Specification.....	7
2.2.1	Mechanical.....	7
2.2.2	Electrical.....	7
2.2.3	Communication.....	8
2.2.4	Environmental.....	8
2.2.5	Optical.....	8
2.2.6	Pneumatic.....	8
2.2.7	Acoustic noise.....	8
2.2.8	Opacity.....	8
<b>3</b>	<b>Functional Description.....</b>	<b>9</b>
3.1	Mechanical Interface.....	10
3.1.1	Design.....	10
3.1.2	Markings.....	10
3.1.3	Hose Assembly.....	10
3.2	Optical Bench.....	10
3.3	PNEUMATICS.....	11
3.3.1	Sample tube.....	11
3.3.2	Air-Knife-System.....	11
3.3.3	Fans.....	11
3.4	ELECTRONICS.....	11
3.4.1	Microcontroller PCB inside the optical housing.....	11
3.4.2	Lamp Control.....	11
3.4.3	Detector Heater Control.....	12
3.4.4	Adjustment.....	12
3.4.5	AC Distribution p.c. Board.....	12
3.5	EXTERNALS.....	12
3.5.1	Cleaning Brush.....	12
3.5.2	Power Cord.....	12
3.5.3	Optional Communication Harness.....	12
3.5.4	Optional Glass-Attenuators.....	12
<b>4</b>	<b>Communication Description.....</b>	<b>13</b>
4.1	Serial Communication.....	13
4.2	Communication Interface.....	13
<b>5</b>	<b>APPENDIX A OPTRANS 1600 Data Flow Diagram.....</b>	<b>14</b>
<b>6</b>	<b>APPENDIX B: Remote control and display unit.....</b>	<b>15</b>

6.1.1	Menü:.....	17
<b>7</b>	<b><i>APPENDIX C: Remote control and display unit.....</i></b>	<b><i>19</i></b>

# 1 Introduction

## 1.1 General

This manual describes the OPTRANS 1600 (230 V, 24 V and 12V) unit. The OPTRANS 1600 for 230V has an internal mains power supply. The OPTRANS 1600 for 24V/12V is equipped with an internal switching power supply and provides +12V, 3 A (peak 5 A) for external use through the communication connector.

All explanations are valid for the above mentioned types. Therefore the product's name is just OPTRANS 1600. Specific characteristics of the different OPTRANS 1600 types are pointed out where it is necessary.

## 1.2 Safety Instructions

NOTE: This apparatus has been designed and tested as a Class 1 device according to DIN 57 411 Pt.1/VDE 0411 Pt.1, Safety Requirements for Electronic Measuring Apparatus, and has been supplied in a safe condition. The present instruction manual contains information and warnings which shall be followed by the user to ensure safe operation and to retain the apparatus in safe condition.

WARNING! Any interruption of the protective conductor inside or outside the apparatus or disconnection of the protective earth terminal is likely to make the apparatus dangerous. Intentional interruption is prohibited.

This device must be connected to another apparatus that has an on/off switch. Before switching on the apparatus, make sure that it is set to the voltage of the power supply.

The mains plug shall only be inserted in a socket-outlet provided with a protective earth contact. The protective action shall not be negated by the use of an extension cord without protective conductor.

The opening of covers or removal of parts, except those to which access can be gained by hand, is likely to expose live parts and high temperature components.

The apparatus shall be disconnected from all voltage sources before any adjustment, replacement or maintenance and repair during which the apparatus shall be opened.

If afterwards any adjustment, maintenance or repair of the opened apparatus under voltage is inevitable, it shall be carried out only by a skilled person who is aware of the hazard involved.

Make sure that only fuses with the required rated current and of the specified type are used for replacement. The use of mended fuses and the short-circuiting of fuse holders shall be avoided.

Whenever it is likely that the protection has been impaired, the apparatus shall be made inoperative and be secured against any unintended operation.

## 1.3 General

The Opacity Transducer OPTRANS 1600 is designed to measure the smoke emissions of diesel cars and trucks. The OPTRANS 1600 uses the partial stream technique which provides for direct and continuous measurement of the smoke sample. This technique measures the amount of light blocked by the sample on a scale of zero opacity to black with zero obscurity indicating no smoke in the sample cell and black indicating that the tube is completely blocked. Design criteria conform to French NF R 10-025, the German PTB EO 18-09, ISO 11614 draft and ECE R24, Annex 8/9 specifications.

## 1.4 Unpacking and Inspection

A shipping carton that appears damaged should be inspected and unpacked with the carrier's agent present. Inspect the instrument for damage (scratches, dents, etc.).

If the instrument is found to be damaged upon receipt, notify the carrier and Sensors Europe immediately. Retain the shipping carton and the padding material for the carrier's inspection, and for return shipment.

## 1.5 Installation

The opacity unit is shipped with the probe detached. The probe is secured by a screw clamp located on the silicone rubber hose. Also included is a 20 mm brush for cleaning.

## 1.6 Storage

It is strongly recommended that the OPTRANS 1600 be packed as if for re-shipment. Environmental conditions during storage and re-shipment should be as follows:

- A) Maximum temperature: 55°C
- B) Minimum temperature: -32°C

## 1.7 Repackaging for Shipment

If possible, use the original shipping container and packing materials. Otherwise:

- A) Wrap the OPTRANS 1600 in heavy paper or plastic before placing it in the shipping container.
- B) Use plenty of packing material around the instrument, and protect the front panel with cardboard or plastic bubble packing. Protect the instrument with two inch rubberised foam pads placed along all surfaces of the instrument, or with a layer of excelsior about 150 mm thick packed firmly against all surfaces of the instrument.
- C) Use a strong, well-sealed shipping container.
- D) Mark the container "FRAGILE - DELICATE INSTRUMENT."

### 1.7.1 Interface

#### **OPTRANS 1600 (230V and 24V/12V):**

The OPTRANS 1600 is powered by two separate connectors located on each side of the unit. The 230 VAC connector is an IEC 320 style that supplies power to the fans, heaters and an isolation transformer. The +/- 12 VDC power is supplied on the opposite side via a AMP CPC 14-pin connector unless the unit is equipped with the optional Internal Power Supply (OPTRANS 1600). The AMP CPC 14-pin connector also includes the RS232 transmit and receive line to communicate to the display.

#### **OPTRANS 1600 (24V/12V):**

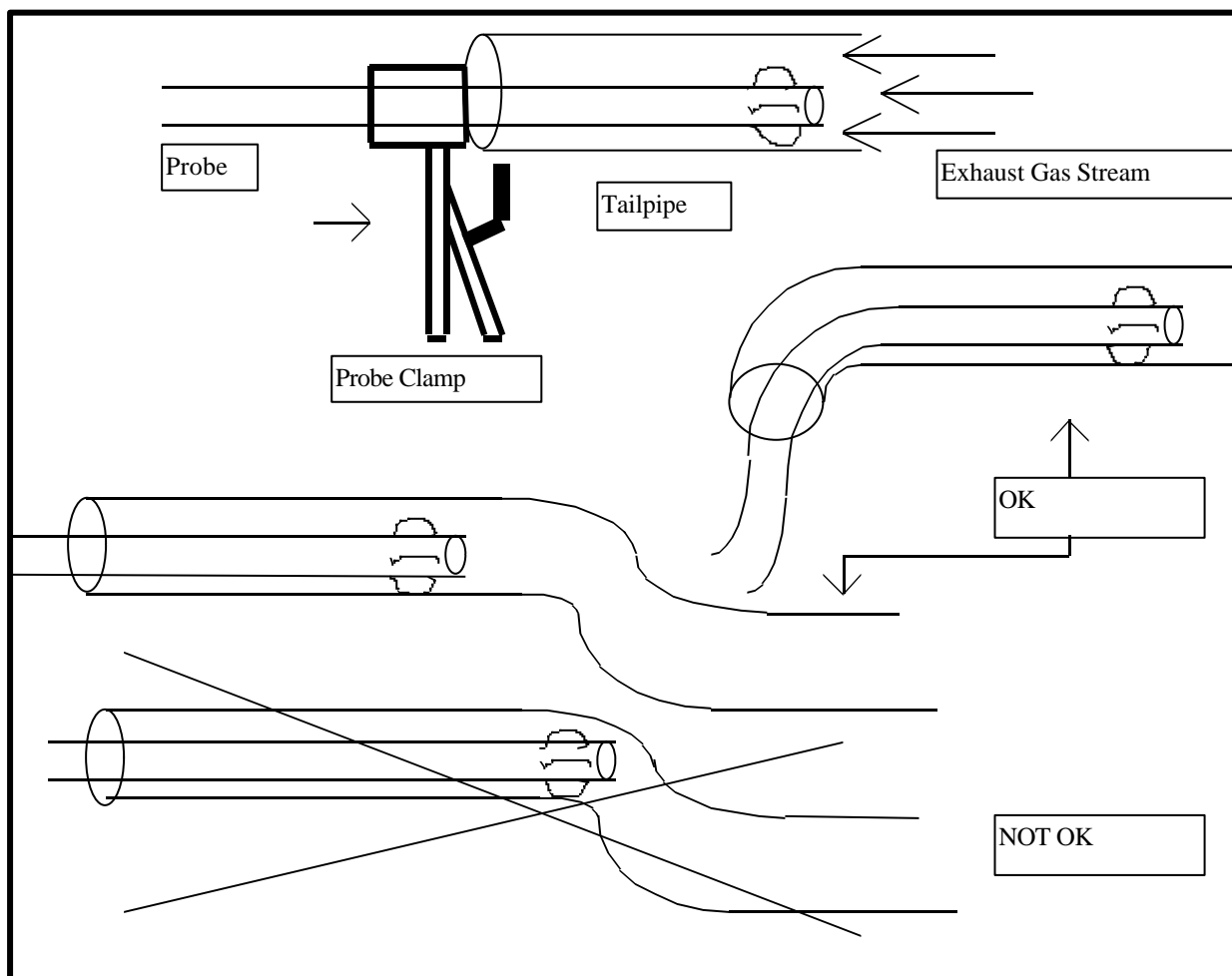
The OPTRANS 1600 24V/12V has in addition an internal switching power supply that provides another +12 VDC power to an external electrical device. This power is connected to pin 8 of the AMP CPC connector on the backside of the unit.

## 1.8 Operation and Probe Instruction

The OPTRANS 1600 is operated in three different modes. The first two methods display the real time data on a screen in order to visually observe exhaust opacity and other internal OPTRANS 1600 measurements. The third method is used for acceleration testing and records opacity for ten seconds prior to or while uploading the data to a host computer. Refer to Section 5 for software implementation of all three methods.

The following procedure insures that the OPTRANS 1600 is operating properly.

- A) Apply AC and DC power.
- B) Determine that both fans are operating. Fans are disabled during warmup for approximately. 3 - 8 minutes.
- C) Remove the probe from the tailpipe.
- D) Calibrate the OPTRANS 1600
- E) Select the real time mode and observe the opacity reading.  
The displayed readings should be approximately. 0% . If this result is not observed, repeat the calibration step.
- F) After Calibration was performed properly, connect the probe to the tailpipe.  
Therefore the probe should be inserted approximately 30 cm into the tailpipe, unless the design / arrangement of the tailpipe does not allow this deep. In this case introduce the probe into the tailpipe as far as possible parallel to the tailpipe wall.  
After inserting the probe, fix the position of the probe with the clamp at the wall of the tailpipe.  
**Note : Take sample into probe where probe and gas stream in parallel.**



## 2 System Requirements

### 2.1 General Requirements

- Opacity type
  - Partial flow
- Tests
  - Free Acceleration
- Reliability
  - 20,000 hrs.
- Ergonomics
  - Light Weight
  - Small Size
- Environment
  - Garage Environment
- Electrical Interface
  - Compatible with DOT/MDOT
- Software Interface
  - Mostly Compatible with DOT/MDOT
- Compliance
  - ISO 11614 (draft 4/10/92)
  - IEC 801-1/-2/-3/-4
  - German PTB EO 18-09
  - French specification NF R 10-025 (UTAC)
  - Dutch specification for Smoke Meters Version 10.1
  - Italian specification, Gazzetta Ufficiale Nr. 293, del 14/12/96
  - UK specification, MOT/07/24/Smoke 2<sup>nd</sup> rev, Oct. '95
  - TÜV Safety/ GS label acc. to EN 61010
  - CE Requirements
    - EN 50 081-1/-2
    - EN 50 082-1/-2

### 2.2 Specification

#### 2.2.1 Mechanical

- Size:
  - height = 23.5 cm
  - width = 38 cm
  - depth = 9 cm
- Weight
  - = 4.5 kg

#### 2.2.2 Electrical

without internal power supply and transformer OPTRANS 1600 230V:

**INPUT:**

- 230 VAC + 10 %, - 15 %; 0.67 Amps, 50/60 Hz
- + 12 VDC +/- 5 %; 0.5 Amps
- - 12 VDC +/- 5 %; 0.2 Amps

with internal power supply included OPTRANS 1600 24/12V:

**INPUT:**

- |               |   |   |
|---------------|---|---|
| 230 V version | - | 230 VAC +10 % -15 %; 0.78 Amps, 50/60 Hz        |
| 24 V version  | - | 24 VAC, 5.8 Amps (peak during warmup), 50/60 Hz |
| 12 V version  | - | 12 VAC, 5.8 Amps (peak during warmup)           |

### 2.2.3 Communication

(To remote control and display unit.)

- RS232 async, 9600 baud, no parity, 1 stop bit

### 2.2.4 Environmental

#### Working environment condition:

- Ambient temp. 5°....40° C
- Humidity 0....95 %
- Ambient pollution 2 % max.

#### Storage condition:

- Storage temp. -32 °C....+50 °C

### 2.2.5 Optical

- Physical path length 174 mm
- Optical path length 364 mm
- inner Ø of sample cell 20 mm
- Collimation 3 °
- Source light Green Led 560 nm
- Detector Gallium Arsenide
- Response time 1 msec

### 2.2.6 Pneumatic

- Stability +/- 1.0 %
- Balanced vacuum
- Probes
  - Passenger Car Probe
  - 10 mm (ID) (standard)
  - Truck Probe diameters and lengths (optional)
- Tube Temperature 75 °C nominal

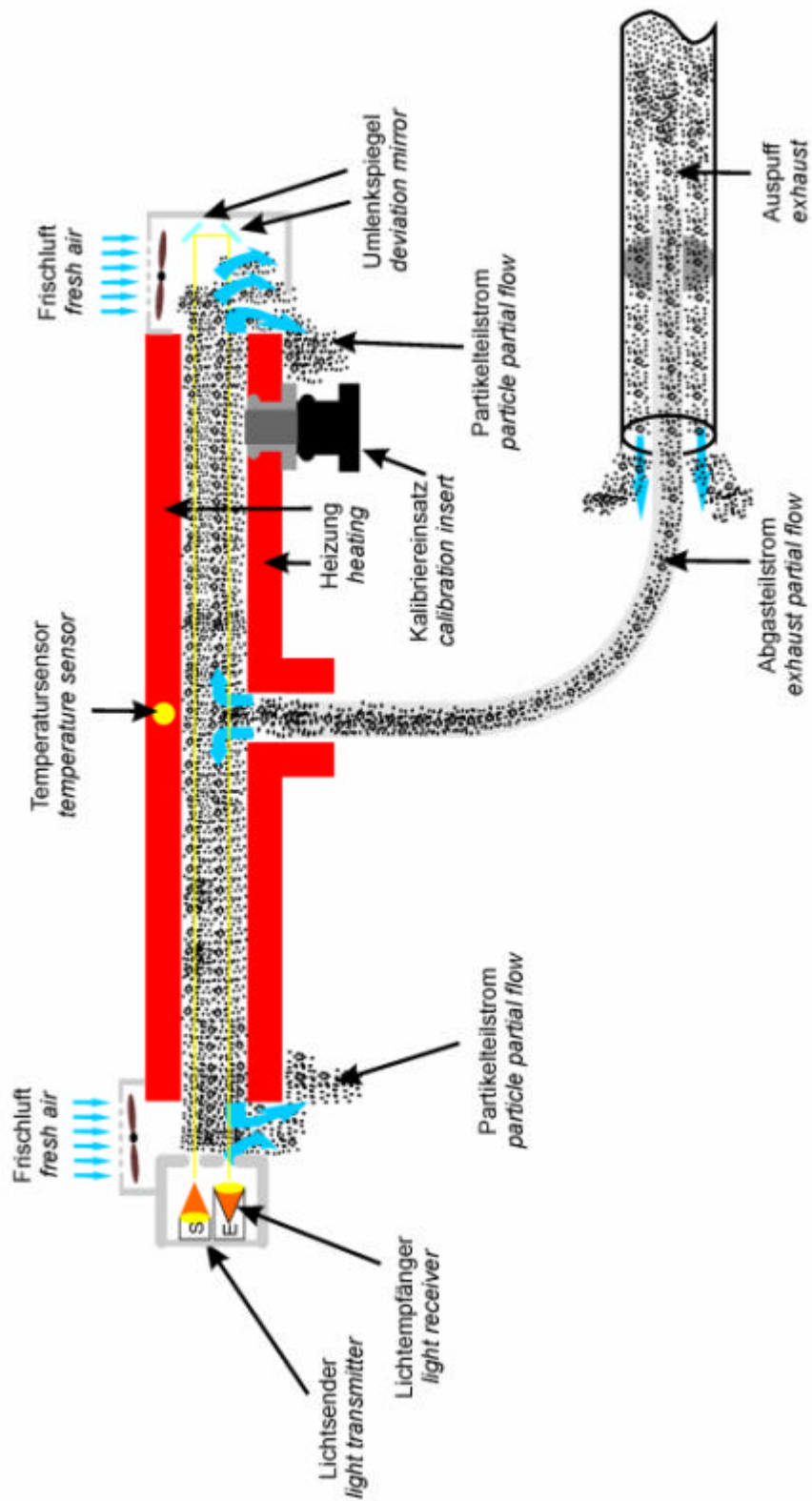
### 2.2.7 Acoustic noise

- 53 dba

### 2.2.8 Opacity

- Accuracy +/- 2 % relative
- Resolution 0.1 %

### 3 Functional Description



## **3.1 Mechanical Interface**

### **3.1.1 Design**

The unit is a true Smoke Bench design. It consists of a metal frame carrying all electrical and mechanical components. The frame is designed to be incorporated into a customized housing. The values are available in the handheld display.

### **3.1.2 Markings**

The serial number tag and logo are located on the bottom of the connector plate. The connector plate is black anodized. The surrounding screws are zinc plated (clear).

### **3.1.3 Hose Assembly**

The car probe consists of a stainless steel probe and silicone hose material. A handle and clamp assembly is attached to the probe in order to affix the probe to the tailpipe.

## **3.2 Optical Bench**

The optics is based on a folded light path and consists of a green LED, detector, mirror, convex lens and a beam splitter. With the source positioned  $90^\circ$  to the optical axis and the beam splitter at  $45^\circ$  the light is reflected by the beam splitter and collimated by the plano lens. It travels through the sample tube and is reflected at the mirror, located on the opposite side. From there it travels back through the sample cell and the lens straight to the detector.

Included in the optical housing is the detector heater that maintains the detector at  $45^\circ\text{C}$ .

The sample tube is heated to  $75^\circ\text{C}$  to avoid condensation, as well as to eliminate autozero errors caused by a change in intensity due to refraction of light at different temperatures. Also this guarantees a minimum temperature in all location of the sample cell of  $> 70^\circ\text{C}$ .

### 3.3 PNEUMATICS

#### 3.3.1 Sample tube

The sample tube provides the means of containing the flow of gas in order to be optically measured while heating the sample to prevent thermal phoretic deposition. The length of the tube and the diameter geometrically determines the collimation of light to be measured. The tube is threaded to further reduce surface reflections.

#### 3.3.2 Air-Knife-System

The Air-Knife-System physically connects the sample tube to the optical housing assembly. Located inside and immediately above the sample tube outlet is a 2,54 mm diameter pin. This pin causes a venturi effect creating a slight vacuum for air flow without load. This process allows the sample chamber to purge prior to a calibration. The air knife also provides a thermal barrier between the sample tube (75° C) and the optical housing (45° C).

#### 3.3.3 Fans

The two fans generate sufficient laminar air flow to overcome the horizontal momentum of the gas particles. This prevents the optical parts (lens, mirror) from collecting dirt. The air flow also stabilizes the internal case temperature and cools the optical housing.

### 3.4 ELECTRONICS

#### 3.4.1 Microcontroller PCB inside the optical housing

The 80C198 is a 16 bit microcontroller operating at 12 MHz. Internal to the controller are the following functions:

- 16 bit timer
- 10 bit A/D converter
- Async serial port
- 8 I/O ports
- Pulse width modulator output
- 28 interrupt sources
- Multiply & divide hardware

The external architecture is designed around an 8 bit data bus and a 16 bit address bus and interfaces to a 32k RAM and 32k of ROM. A15 is used to decode the two memory devices.

#### 3.4.2 Lamp Control

A constant current source provides 40 mA to a green LED. This circuit contains an enable line that is controlled by the processor. An additional control line reduces the lamp current to approximately 20 mA. This function allows the OPTRANS 1600 to perform the auto-attenuation feature (auto 50 % linearity check).

### 3.4.3 Detector Heater Control

A linear current supply (200 mA) controlled by the pulse width modulator output.

### 3.4.4 Adjustment

Located on the Microprocessor p.c. Board is the detector gain potentiometer, which is factory adjusted to 3.5 - 4.0 V. The maximum tolerance range for the field is 2800 mV...4600 mV.

### 3.4.5 AC Distribution p.c. Board

This board contains the electrical interface between the processor and the sample tube heater for 230 VAC & 12 VDC. An optional transformer converts 230 VAC into 12 VDC to power the fans. An optional AC/DC converter provides the +/- 12 VDC for the electronics and fans when in external 230 VAC only mode.

## 3.5 EXTERNALS

### 3.5.1 Cleaning Brush

Stainless steel twisted wire with nylon bristles. Flexible enough to enter the sample tube via the air knife opening (1.5" radius bend).

### 3.5.2 Power Cord

External 230 Vac power cord with IEC320 plug and receptacle (20 feet in length).

### 3.5.3 Optional Communication Harness

The external communication harness consists of an AMP CPC 14 Pin connector (male) that interfaces the OP-TRANS 1600 to the remote display unit. The cable is shielded for suppressing high frequency emissions and braided for durability.

### 3.5.4 Optional Glass-Attenuators

High precision glass attenuators fitted in a metal frame for certification purpose are available upon request. For measuring attenuators special commands are to be used!

## 4 Communication Description

### 4.1 Serial Communication

The serial communication is performed between the OPTRANS 1600 and a remote display unit. The following command set defines the serial communication.

Baud	9600
Data Bits	8
Stop Bits	1
Parity	none.

### 4.2 Communication Interface

The serial communication connector on the OPTRANS 1600 is an AMP CPC 14 pin device with pin assignments described below (separated for each style of OPTRANS 1600). The cable shield **MUST** be connected to pin 14 (Chassis Ground) for proper operation . **DO NOT** connect the shield to the metal connector housing (alternate construction for the plastic type).

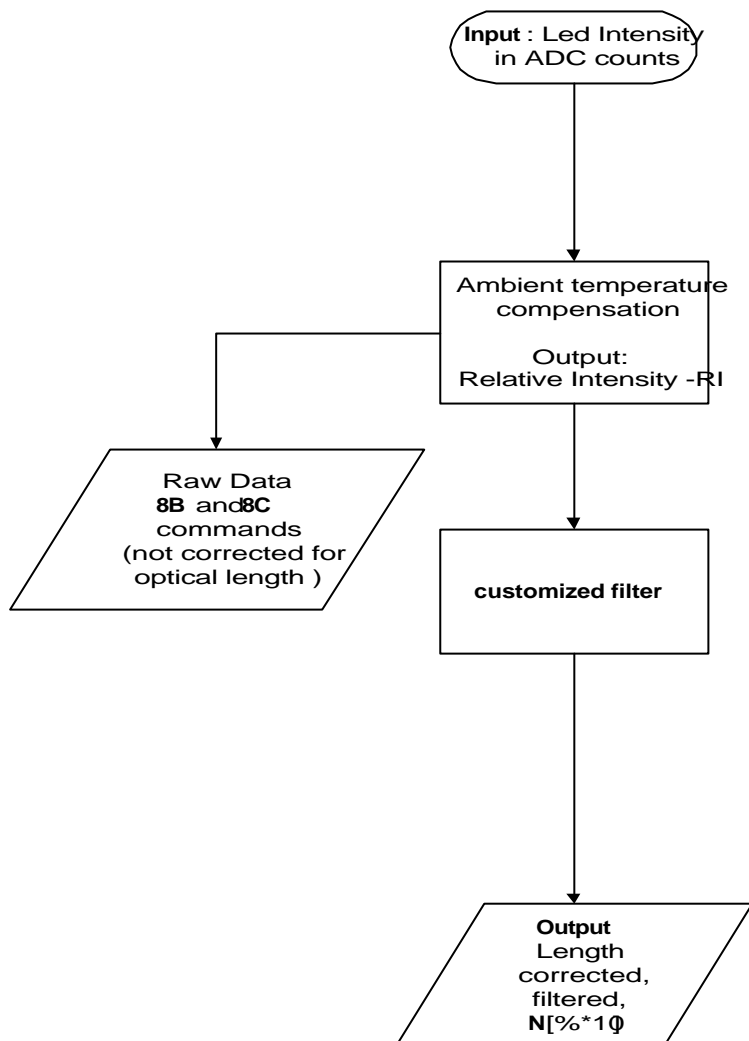
#### OPTRANS 1600 230V:

Pin 2	-	Rx (into OPTRANS 1600)
Pin 3	-	Tx (from OPTRANS 1600)
Pin 8	-	+12 V (1.0 Amps) for fans (required, if no internal transformer)
Pin 11	-	- 12 V (0.2 Amps)
Pin 12	-	Digital (Signal) Ground
Pin 13	-	+ 12 V (0.8 Amps) for electronic p.c. Boards
Pin 14	-	Chassis Ground (Braided Shield)

#### OPTRANS 1600 12V:

Pin 2	-	Rx (into OPTRANS 1600 )
Pin 3	-	Tx (from OPTRANS 1600 )
Pin 8	-	+12 V for external device
Pin 12	-	Digital (Signal) Ground
Pin 14	-	Chassis Ground (Braided Shield)

## 5 APPENDIX A OPTRANS 1600 Data Flow Diagram



Conversion opacity N[%] to  $k[m^{-1}]$

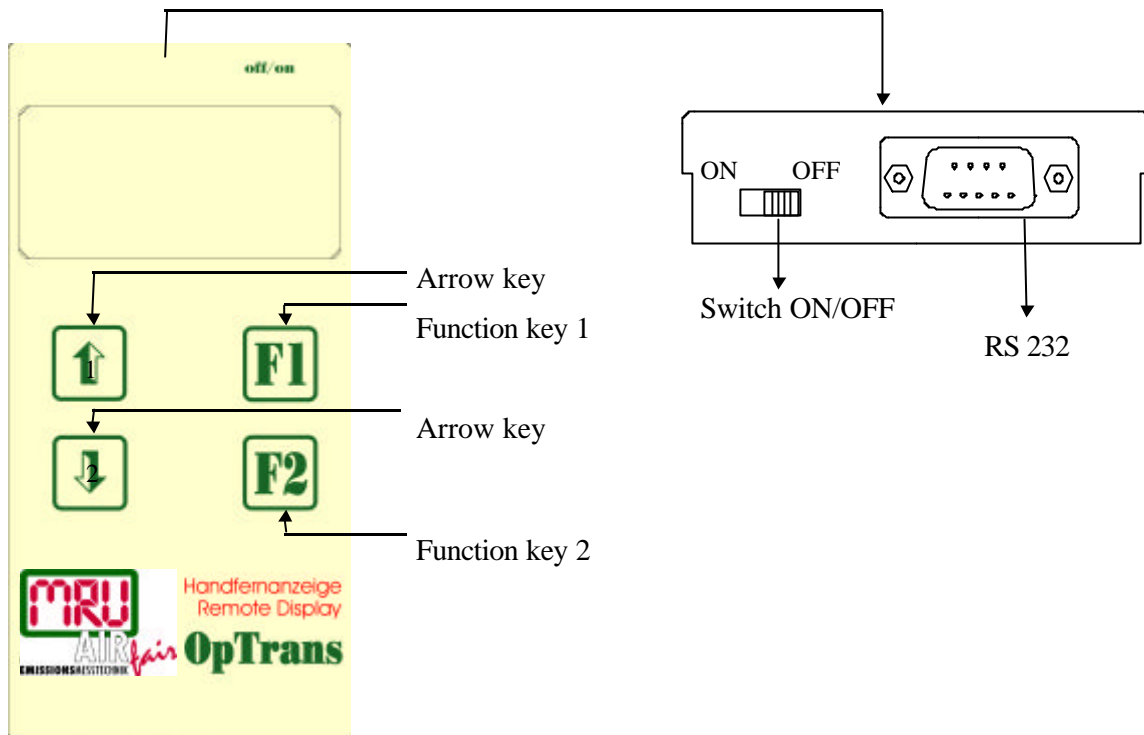
$$k = -\frac{\ln\left(1 - \frac{\text{opacity}}{100}\right)}{l}$$

$k$                     := intensity  
 $\ln$                    := natural logarithm  
 opacity             := opacity  
 $l$                     := 430 mm

The readings in percent from the OPTRANS 1600 to the display are optical path length corrected to match 430 mm unless it is mentioned differently in this manual (e.g. command 0x8b and 0x8c).

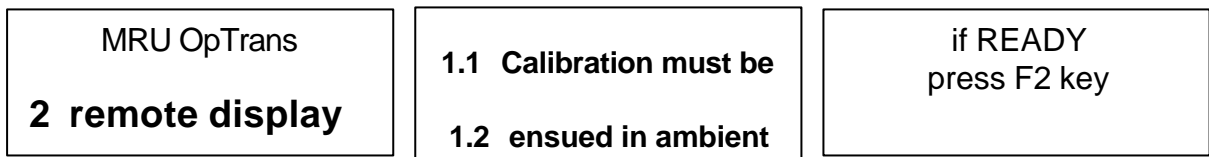
## 6 APPENDIX B: Remote control and display unit

### Front view:

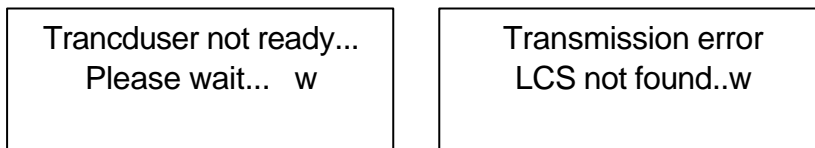


## **Functions :**

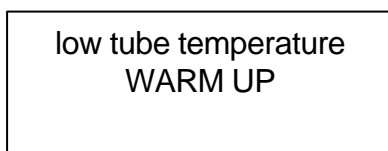
1. Switching the remote display on, following messages appears:



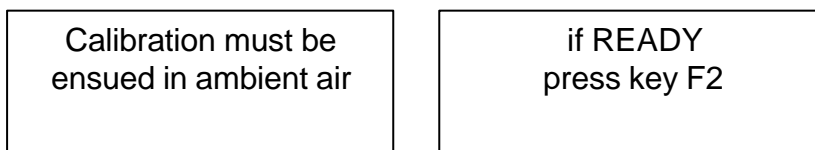
2. If the remote display is switch on without connection to the OpTrans



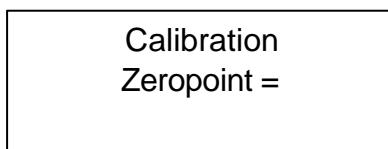
3. If the Optrans is connected but the instrument is still in warm up mode, following message appears:



If the warm up is finish, the van of the OpTrans starts

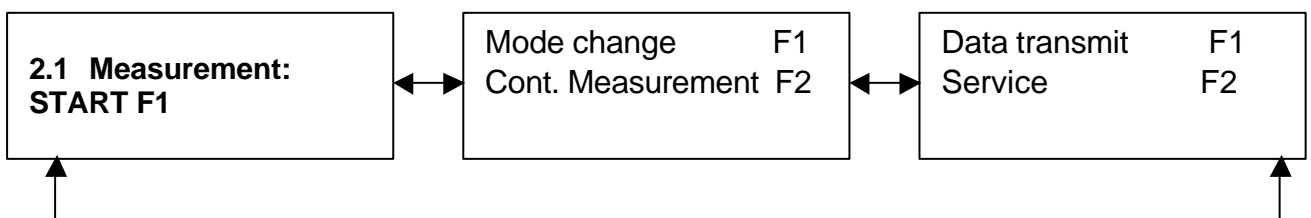


Now the measuring mode can start with F2:

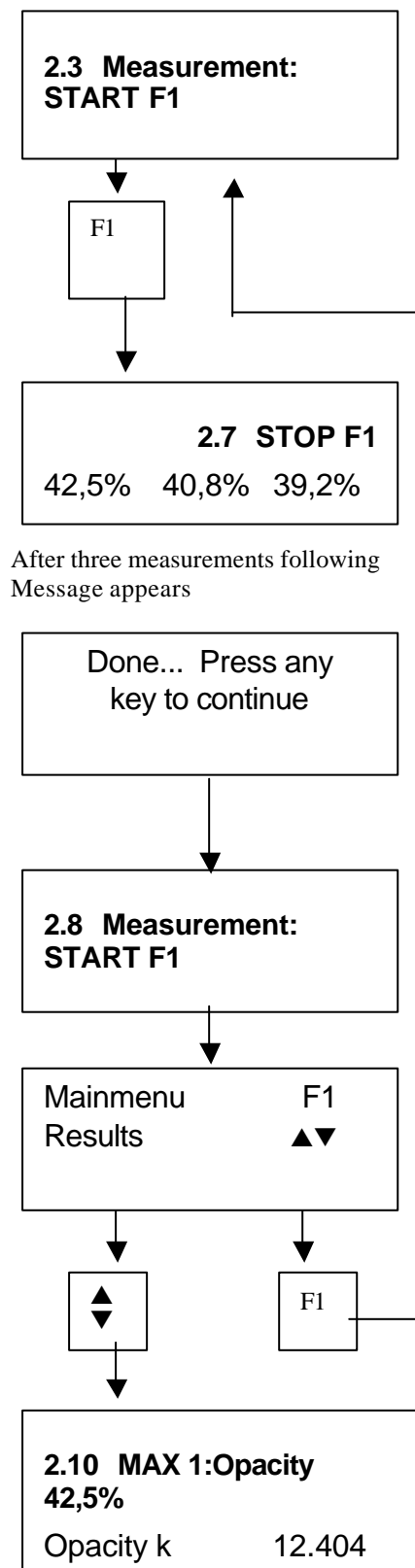


After few seconds the instrument switches in the main menu

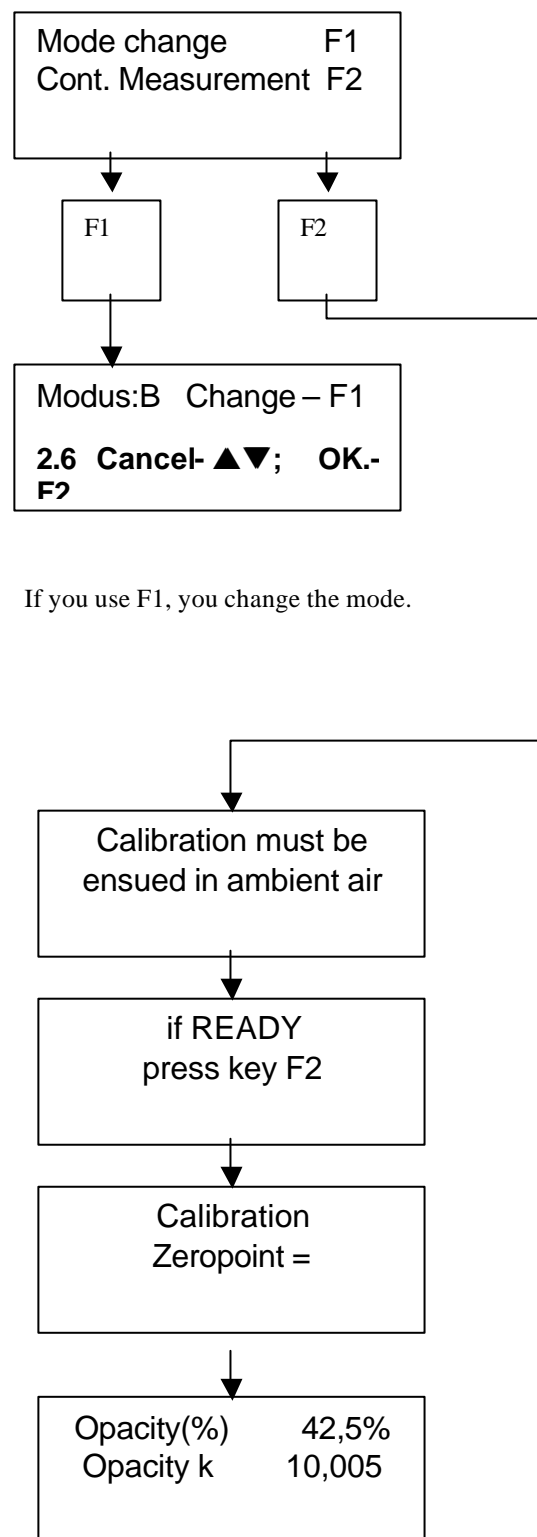
If you use the ▲▼-keys, you can change among three modes.:



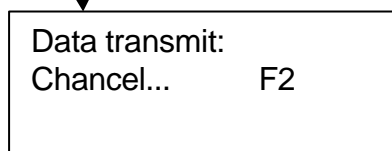
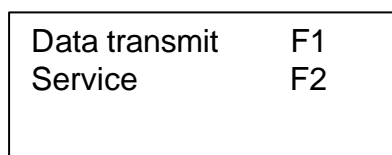
### 6.1.1 Menu



If you use the ▼ key, you switch among the three values in the display.



To Stop the continues measurement you can use any key. .

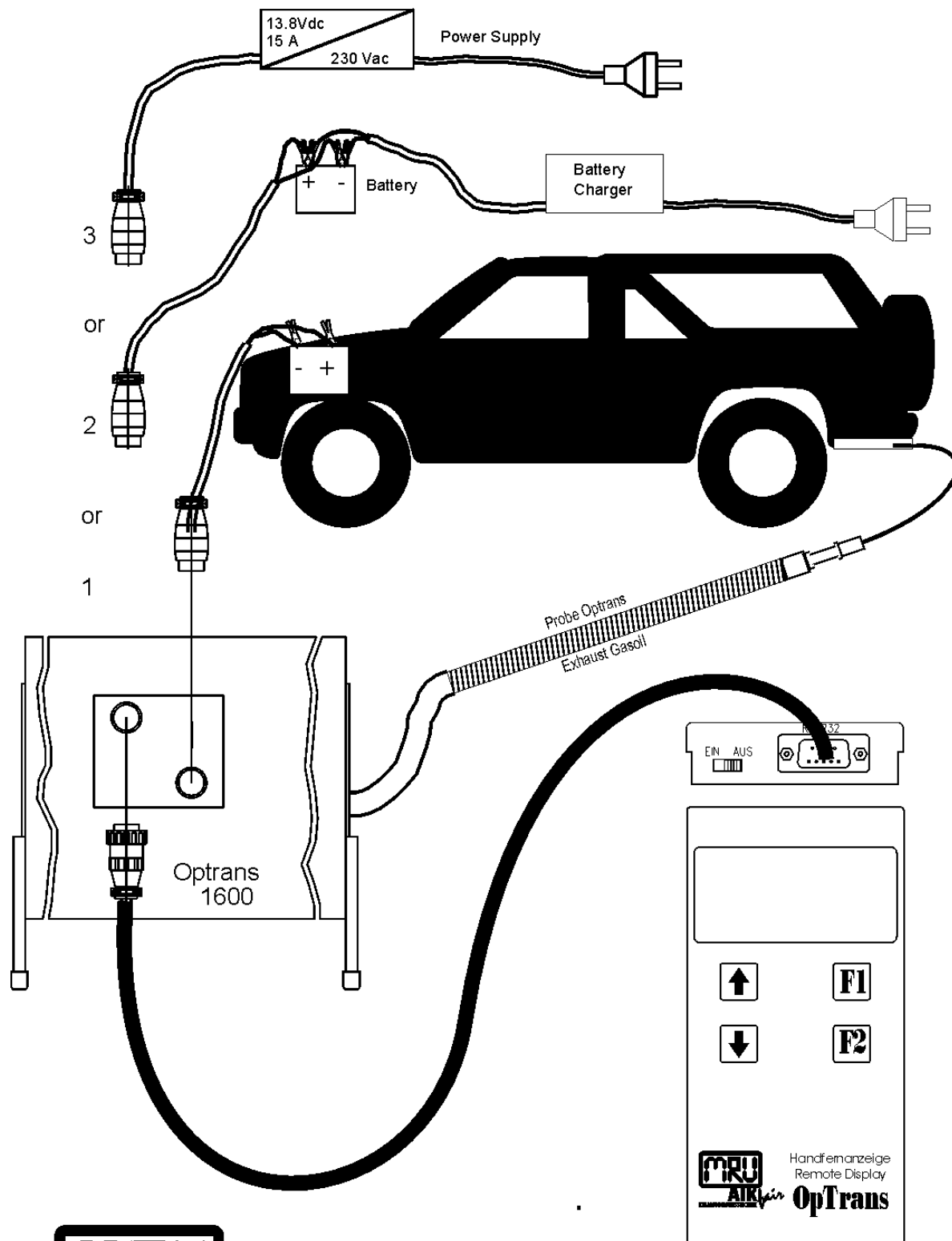
**Menu:**

F1 starts the transfer of the last three values to the DELTA 1600 L

F2 – only for Service

## 7 APPENDIX C: Remote control and display unit

Application with display unit HFA Optrans



Measuring instruments for flue gases  
and environmental protection Ltd.

Fuchshalde 8  
74172 Neckarsulm - Obereisesheim  
Germany

Phone: +49 (71 32) 99 62-0  
Fax: +49 (71 32) 99 62-20  
Internet: <http://www.mru.de>  
E-mail: [info@mru.de](mailto:info@mru.de)